Assessment of the impact of mitigation options on nitrous oxide emissions by the agricultural sector in Europe

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Presentation Outline

- Introduction
- The model INTEGRATOR
- Mitigation measures
- Results
- Conclusions

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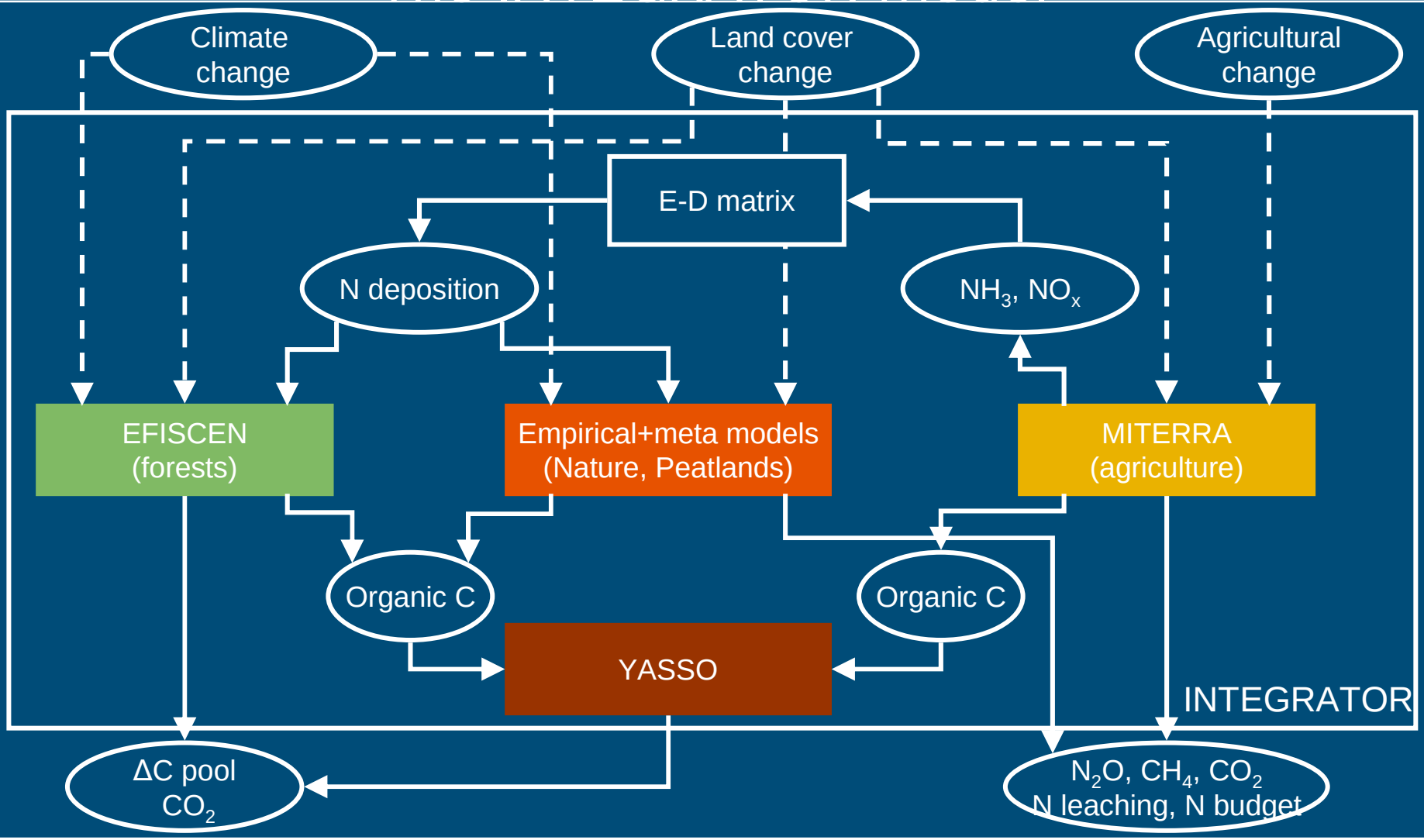
Several methods for Large scale N_2O estimates

- IPCC inventory approach using various default emission factors (Tier 1)
  - Not suitable for the evaluation of measures
- Complex dynamic process models (Tier 3)
  - Extensive data requirement
  - => Mitigation at European scale cumbersome
- Using a relatively simple process based ecosystem model approach (Tier 2) may help to link the default IPCC emission factors (Tier 1) and complex models (Tier 3)

Aim

- European wide N_2O emissions from agriculture, using a 'Tier 2' approach
- Estimate the plausibility:
  - Comparison with country level estimate (Tier 1)
  - Comparison with other model results (Tier2/3)
- Demonstrate the effect of agricultural mitigation options

The INTEGRATOR model



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Adaptations MITERRA in INTEGRATOR

Aspect	MITERRA	MITERRA in INTEGRATOR
Tool	Stand alone policy tool (DG ENV)	Research model
Scale	NUTS 2	NCUs
Time aspect	Steady state model	Build in a dynamic environment
N manure input	Manure distribution model	Adapted from MITERRA-EUROPE
Ammonia emission	From RAINS	From MITERRA-EUROPE
N leaching	MITERRA leaching model	From MITERRA-EUROPE
Nitrous oxide emission	From GAINS	Emission factors as a function of manure type, land use, soil type etc. In future including interactions N and C.

Parameterization of N_2O emissions in INTEGRATOR

N source	Type	Application technique	Soil type	Land use	Precip	pH	temp
Fertilizer	nitrate fertilizer ammonium fertilizer urea		sand/ clay/ peat	grassland/ arable land	3 groups	2 groups	3 groups
Manure	pig slurry	surface/ incorporation					
	pig solid manure cattle slurry						
	cattle soilid manure	surface/ incorporation					
	poultry manure grazing other manure						
Soil organic N	nett mineralization						
Biological N fixation							
Atmospheric deposition							
Crop residues	cereals vegetables arable crops						

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Evaluated Measures

- A. Livestock management and Housing and manure storage
- B. Soil nutrient management
- C. Water management

Livestock management, Housing and manure storage

- 1. Reduced protein content of feed
  - Reduction in N excretion:
    - 15% for cattle
    - 20% for pigs
    - 20% for laying hens and 10% for other poultry
  - → Lower N input
- 2. Low ammonia emission housing and storage
  - Reduction in NH_3 emission
  - Lower N deposition → Lower indirect emission
  - Higher N content in manure → Higher N input → Pollution swapping

Nutrient management: soil

- 3. Balanced fertilization
  - → Lower N input
- 4. Maximum manure application rate
  - → Lower N input
  - May be compensated by fertilizer
- 5. Manure incorporation
  - → Lower NH_3 emissions
  - → Higher N_2O emission (1.5×) (see Lesschen&Velthof)
- 6. Urea substitution by NH_4 fertilizers
  - → Lower N_2O emission (0.67×) (see Lesschen&Velthof)

Water management

- 7. Restoration histosols
  - Mean summer groundwater level → 10 cm
  - No fertilizer application
  - → Lower C and N mineralisation
  - → Lower N input

Results

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European wide N_2O emissions

Emission type	N_2O emissions (kton N_2O-N yr^{-1})		
	Grass	Arable	Total
Housing and storage	-	-	54
Application	49	67	116
Grazing	105	0	105
Other Inputs [1)]	10	61	71
Total	164	129	347

[1)] Deposition, mineralization, fixation and crop residues

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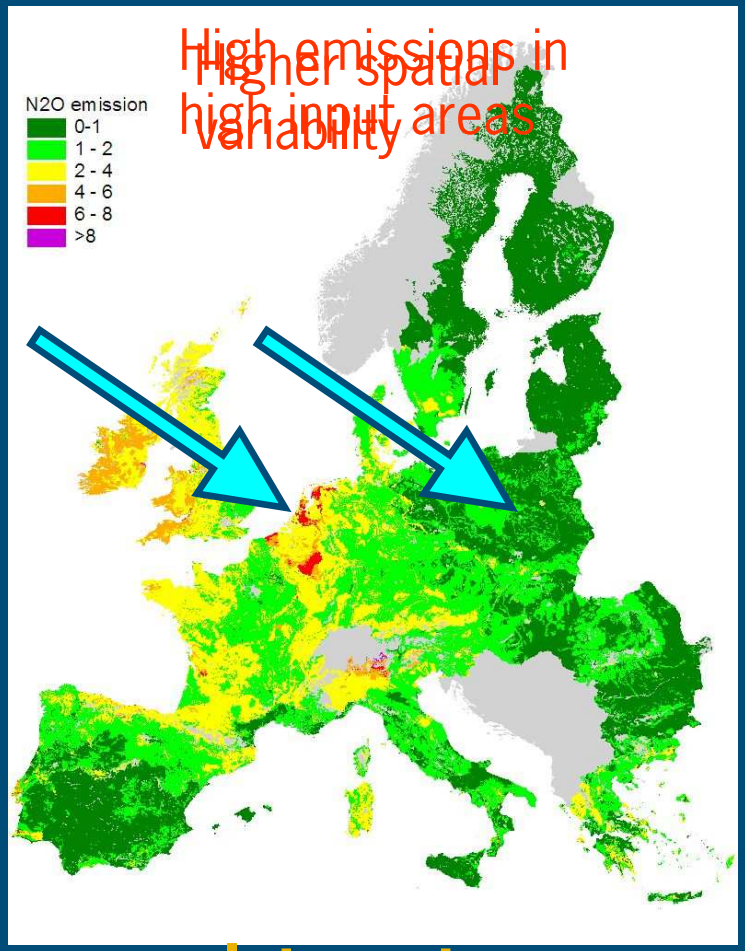
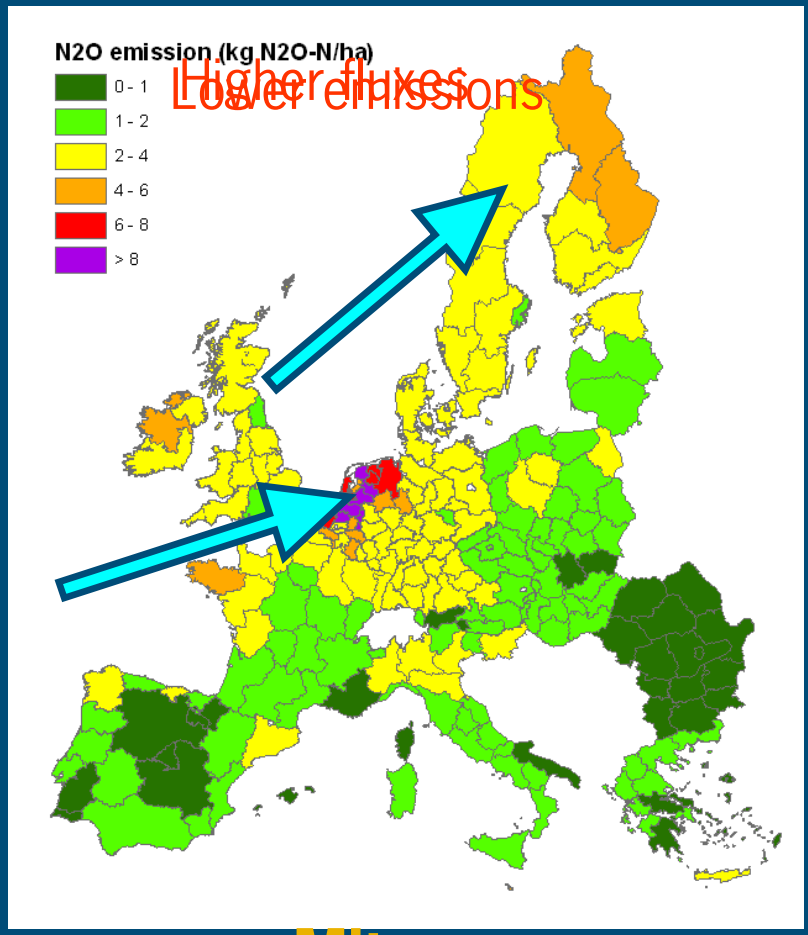
European wide N_2O emissions (Cont'd)



Integrator



Miterra

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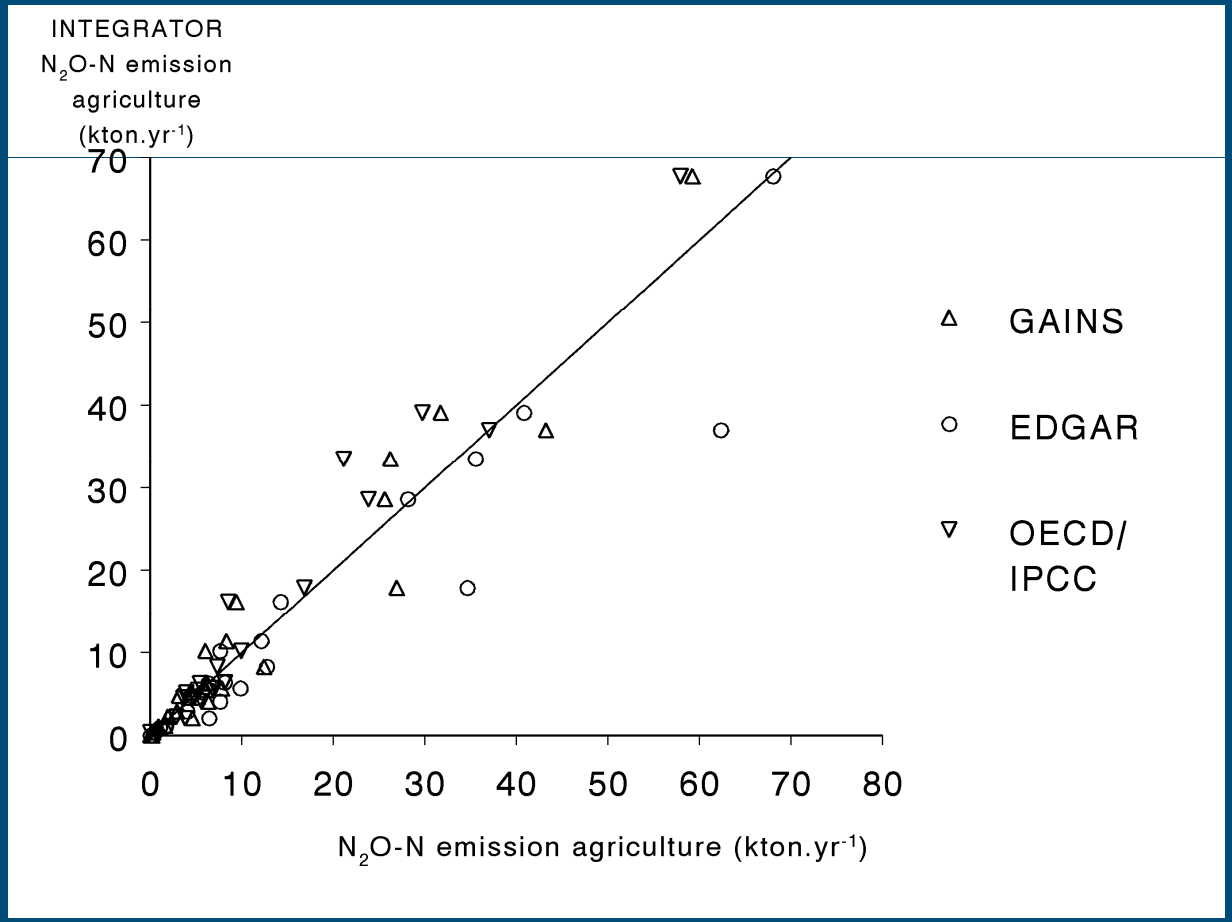
European wide N_2O emissions (Cont'd)

- Results for EU27

Model	N_2O_{em} (kton N_2O-N)	N_2O_{em} (kg N_2O-N ha^{-1})	EU 27 (Mha)
Integrator	347	1.8	193
Miterra	369 (+6%)	2.1 (+17%)	176 (-9%)

Comparison with GAINS, EDGAR, EMEP and OECD/IPCC



Country emissions for N_2O as derived with INTEGRATOR compared with inventory methods for the year 2000

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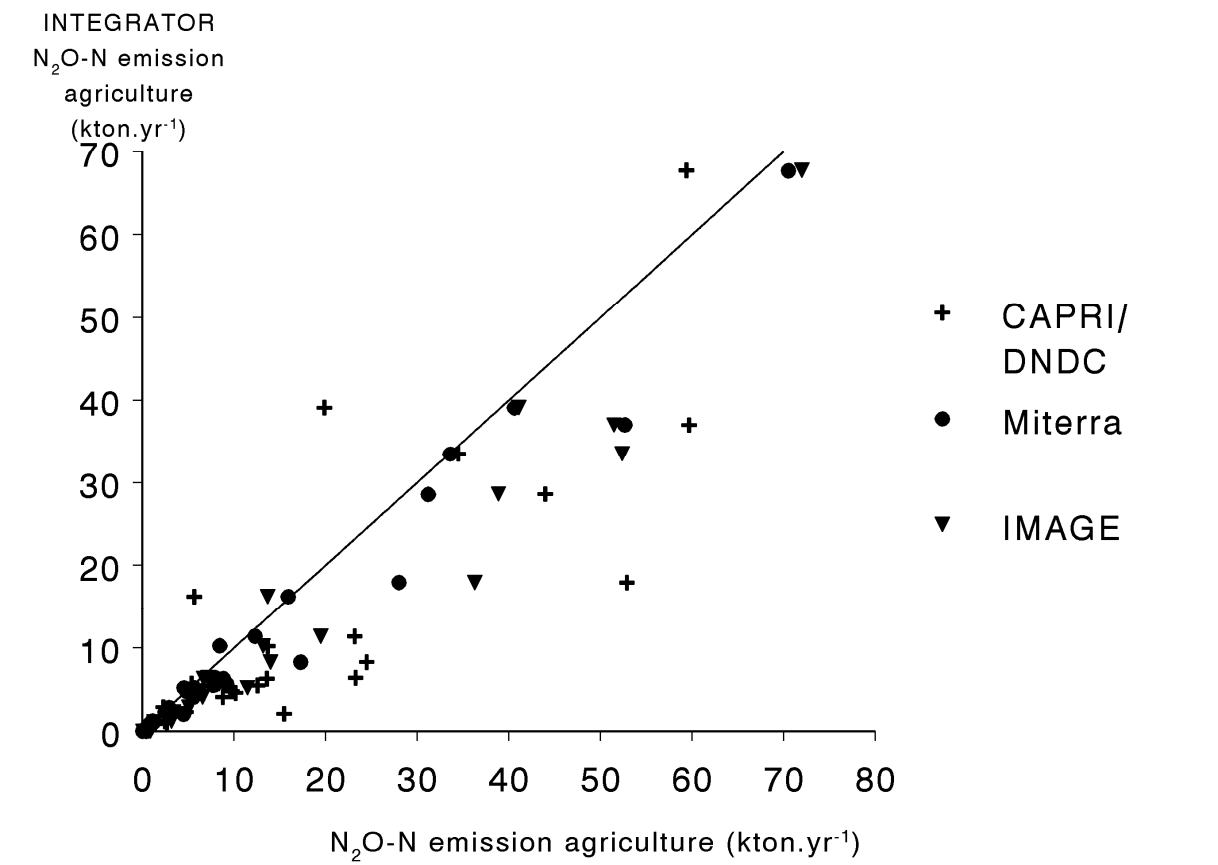
Comparison with DNDC-CAPRI, MITERRA, IMAGE



Country emissions for N_2O as derived with INTEGRATOR compared with other model results for the year 2000

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Response to various mitigation measures

- Relative changes in N_2O emission (%) for EU27

Measure	Housing and storage	Manure and fertilizer application	Other N inputs[1)]	Total
1. Reduced protein content	-1.4	-0.5	0.0	-1.9
2. Low $NH_{3\,em}$ housing, storage	0.0	0.0	0.0	0.0
3. Balanced fertilization	0.0	-8.8	-2.7	-11.5
4. Max manure application rate	0.0	-7.1	0.1	-7.0
5. Manure incorporation	0.0	0.2	0.0	0.2
6. Urea substitution	0.0	-0.3	0.0	-0.3
7. Restoration histosols	0.0	-0.8	-0.2	-1.0
All measures	-1.4	-17.4	-2.7	-21.5

[1)] Includes emission through soil inputs by deposition, mineralization, fixation and crop residues

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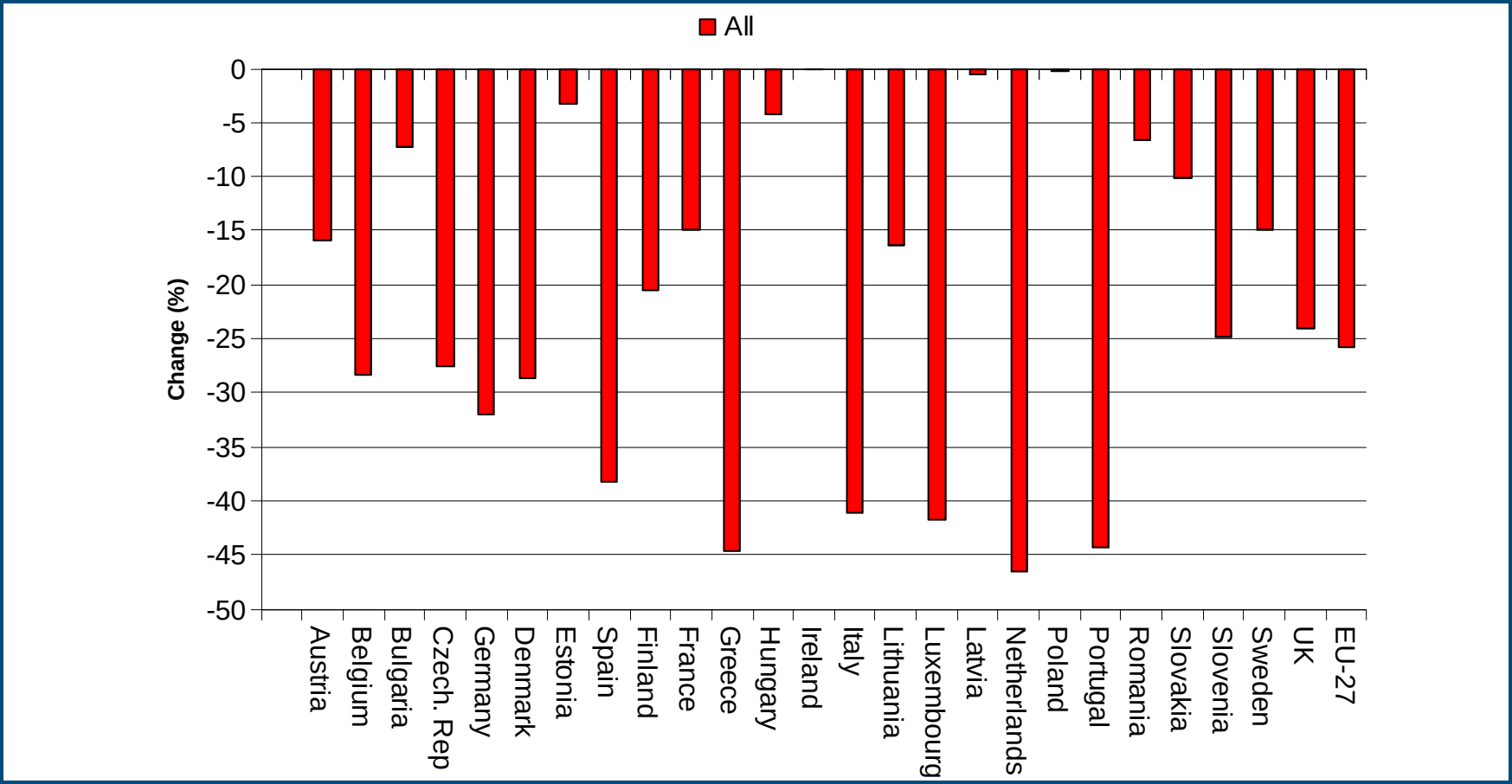
Effect of all measures per country



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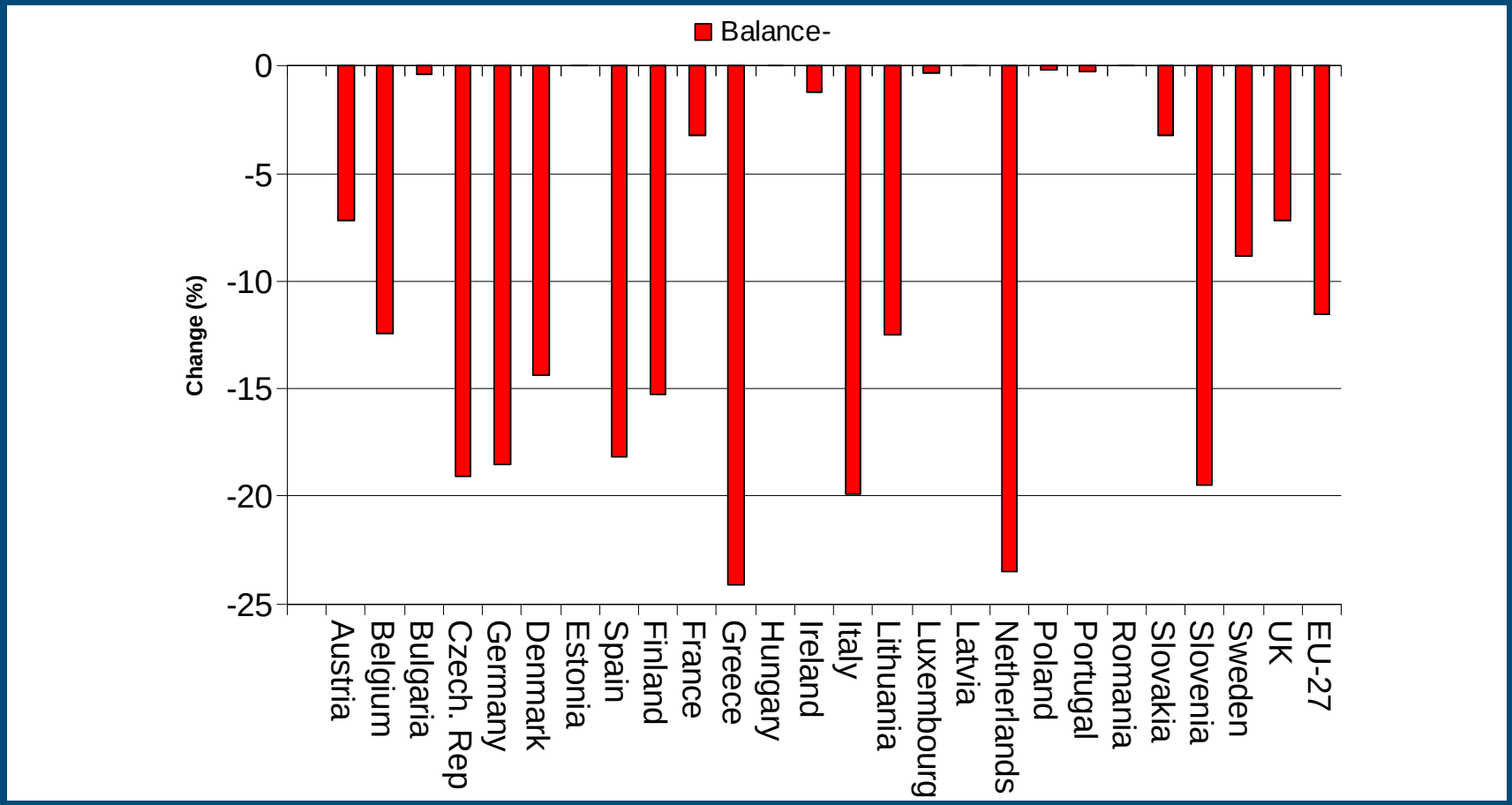
Effect of Balanced fertilization



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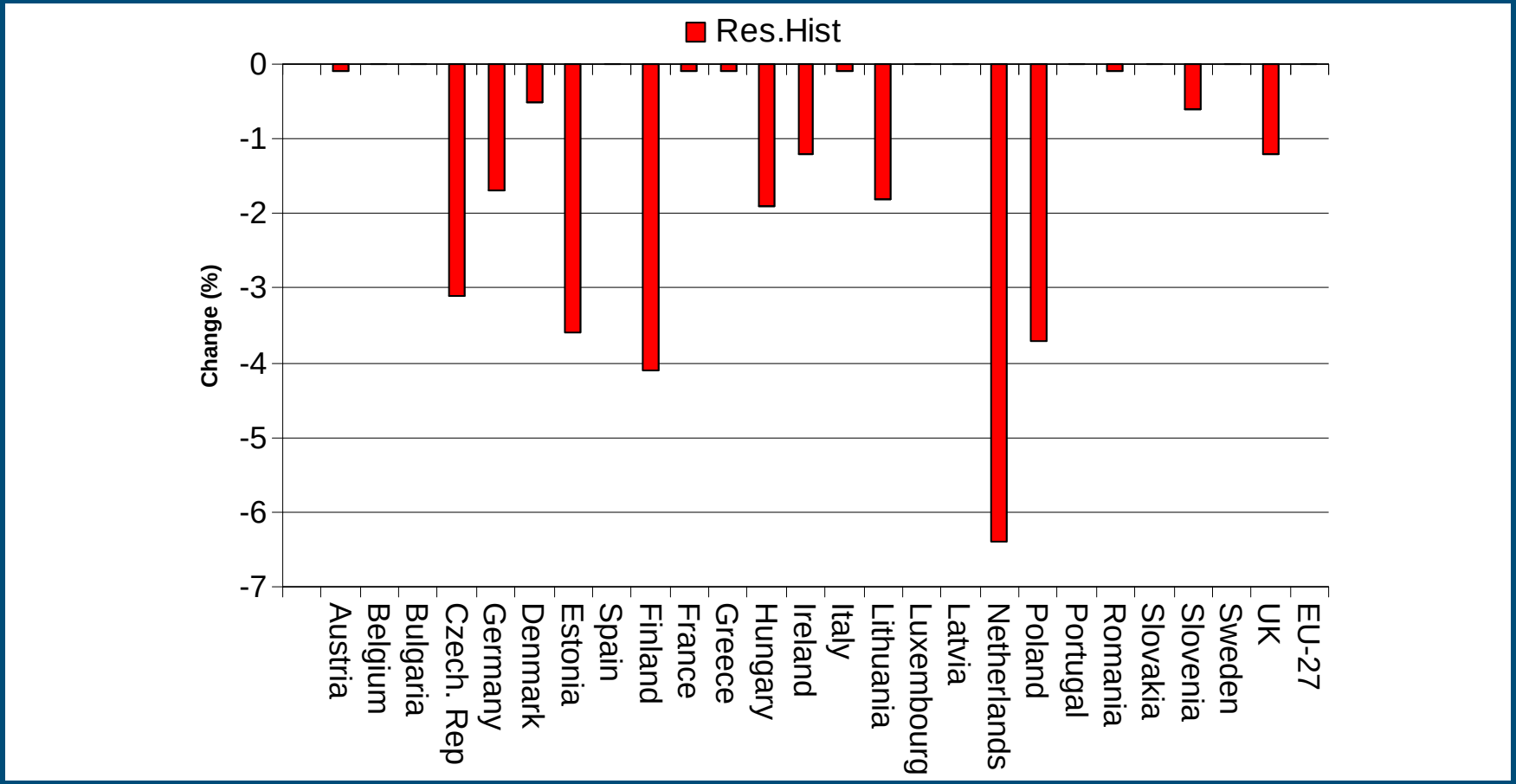
Effect of Histosol restoration per country



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Conclusions

- For the agricultural sector of the EU 27 INTEGRATOR calculates a total N_2O emission of 347 kton N_2O-N for the year 2000
- European wide N_2O emission calculated with INTEGRATOR are comparable to other model estimates
- The overall achievable reduction with the combination of all measures is about 20%, but the variation per country is high
- The most effective measures are:
  - *Balanced fertilization* (-12%)
  - *Maximum manure application* (-7%)
  - *Reduced protein content of feed* (-2%)

Thank You!

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